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Conference Abstract

GBR Data Management System: A One-Stop Shop to Great Barrier Reef Data

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Abstract

Introduction

The Great Barrier Reef (GBR) is one of the world's most biodiverse and ecologically significant marine ecosystems. Its management has increasingly relied on integrating long-term monitoring and modelling to address threats such as ocean warming, land-based pollution, and human activities. Since 2015, comparative studies have demonstrated that data-driven approaches have achieved tangible outcomes, including reductions in pollutant levels in targeted catchments and localised coral recovery through a targeted Crown-of-Thorns Starfish (COTS) control program. However, these efforts are often constrained by fragmented data access, attribution challenges, and the urgency of monitoring climate drivers.

Built on open-source technologies and aligned with FAIR (Findable, Accessible, Interoperable and Reusable) data principles, the Great Barrier Reef Data Management System (DMS) serves both the Great Barrier Reef Marine Park Authority (GBRMPA) and the broader research community. It enables users to discover, access, and analyse data through robust APIs, reducing data wrangling. As reef managers increasingly rely on scenario modelling, spatial risk assessments, and participatory monitoring frameworks, the DMS provides support for these approaches at scale.

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System Overview

The DMS was developed as a key infrastructure to support the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP). Led by the Integrated Marine Observing System (IMOS), the DMS is designed to serve as a scalable, cloud-native platform that aggregates, harmonises, and delivers more than 170 datasets critical to the management of the GBR. See Suppl. material 1 for a detailed system description.

Impact and Use Cases

1. **Enabling Evidence-Based Decision-Making.** The DMS directly supports RIMReP by providing timely, standardised data to inform management decisions. For example, the system underpins the CoTS Control Program, which relies on integrated datasets from the Australian Institute of Marine Science (AIMS), eReefs, and GBRMPA to monitor outbreaks.
2. **Accelerating Research and Innovation.** A significant impact of the DMS is its support for open, reproducible science. The project maintains two public repositories: rimrep-examples and rimrep-training. These resources demonstrate how to discover and filter datasets; and extract and analyse spatial and temporal subsets of data, manually or automatically.
3. **Reducing Technical Overhead and "Data Wrangling."** One of the most immediate impacts of the DMS is the reduction in time and effort required to access and prepare data for analysis. For example, accessing satellite-derived sea surface temperature data across 18,000 layers can be done in under 12 seconds, directly connecting to the DMS storage.

Lessons Learned and Future Directions

1. **Data Harmonisation is Essential but Complex**. The adoption of cloud-optimised formats (Zarr and GeoParquet) improved performance and usability across diverse datasets. However, harmonising formats from >60 providers required significant effort, especially for legacy datasets. The use of the Frictionless framework proved critical in maintaining metadata quality and consistency.
2. **Automation Enables Sustainability.** Automated ingestion workflows, including "watchers" that detect updates from data providers, have reduced manual overhead and improved data freshness, crucial for long-term sustainability, particularly as the number of datasets continues to increase.
3. **Performance Matters for Usability.** Improvements in file structure and indexing have significantly reduced query times, enabling real-time analyses and dashboard integration, particularly with terabyte-sized datasets such as eReefs and satellite-derived products.
4. **Engagement Drives Adoption.** Training workshops and public code repositories were instrumental in building trust and capacity among users. User feedback informed improvements to documentation and use cases.

Conclusion

The GBR DMS aligns with the Ocean Decade Data and Information Strategy and embodies its core principles of FAIR data practices, open-source infrastructure, and equitable access. By reducing technical barriers and enabling rapid access to high-quality environmental data, the DMS serves as a strategic enabler for transformative ocean science and management. The DMS is currently managed by AIMS, which is strategically positioned to foster collaboration among data providers, managers, researchers, and Traditional Owners of the Sea Country.

Keywords

cloud optimised, Reef 2050 RIMReP, data harmonisation, evidence-based decision-making, marine park, FAIR data

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Conflicts of interest

The authors have declared that no competing interests exist.

Supplementary material

Suppl. material 1: S1 - System Architecture doi

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Data type: PDF document
Brief description: Detailed description of the Great Barrier Reef DMS system architecture.
Download file (305.60 kb)